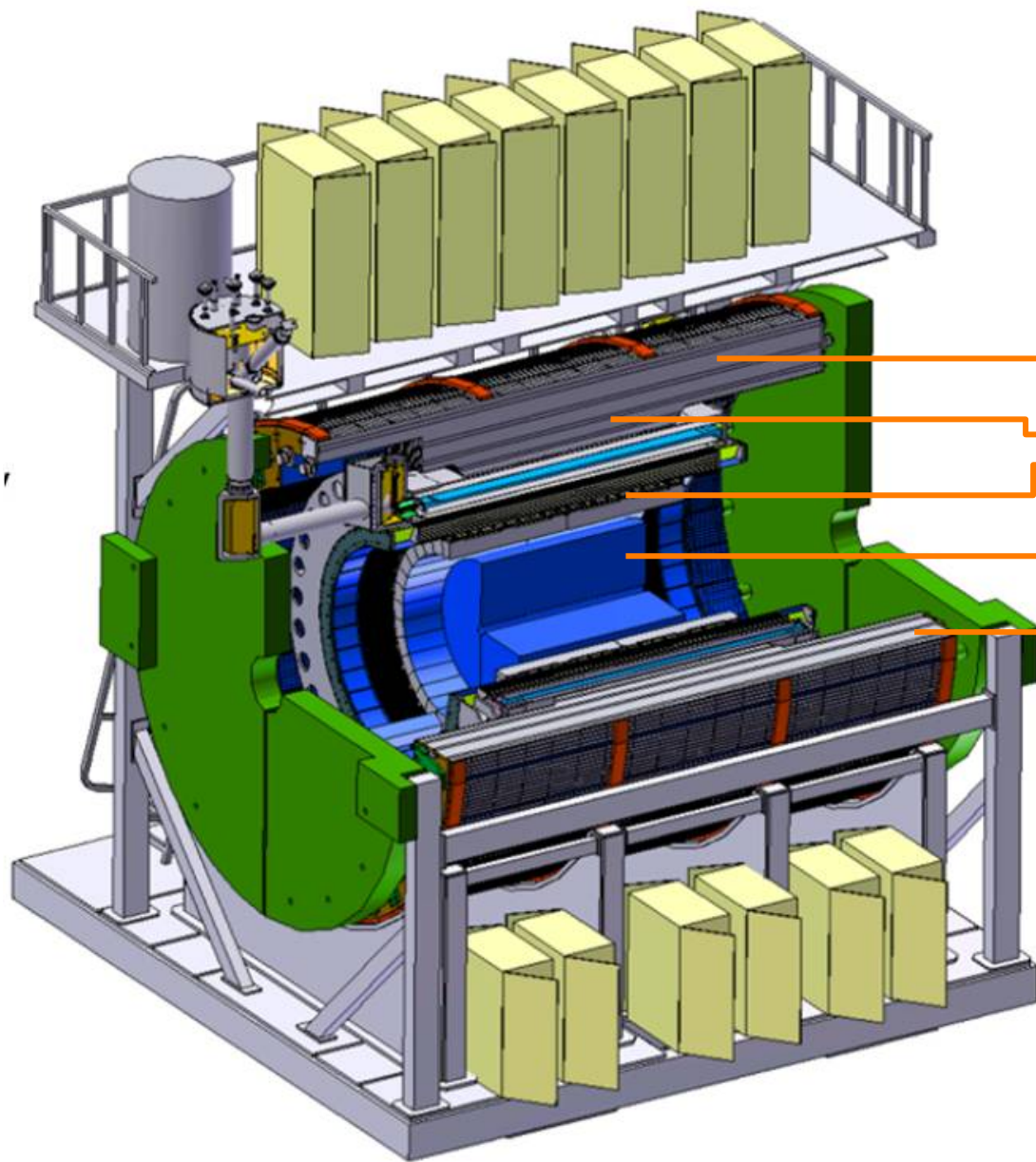


WBS 1.6 – DAQ-Trigger



WBS sPHENIX MIE Project Elements

- 1.1 Project Management
- 1.2 Time Projection Chamber
- 1.3 Electromagnetic Calorimeter
- 1.4 Hadron Calorimeter
- 1.5 Calorimeter Electronics
- 1.6 DAQ/Trigger
- 1.7 Minimum Bias Trigger Detector

WBS Infrastructure & Facility Upgrade

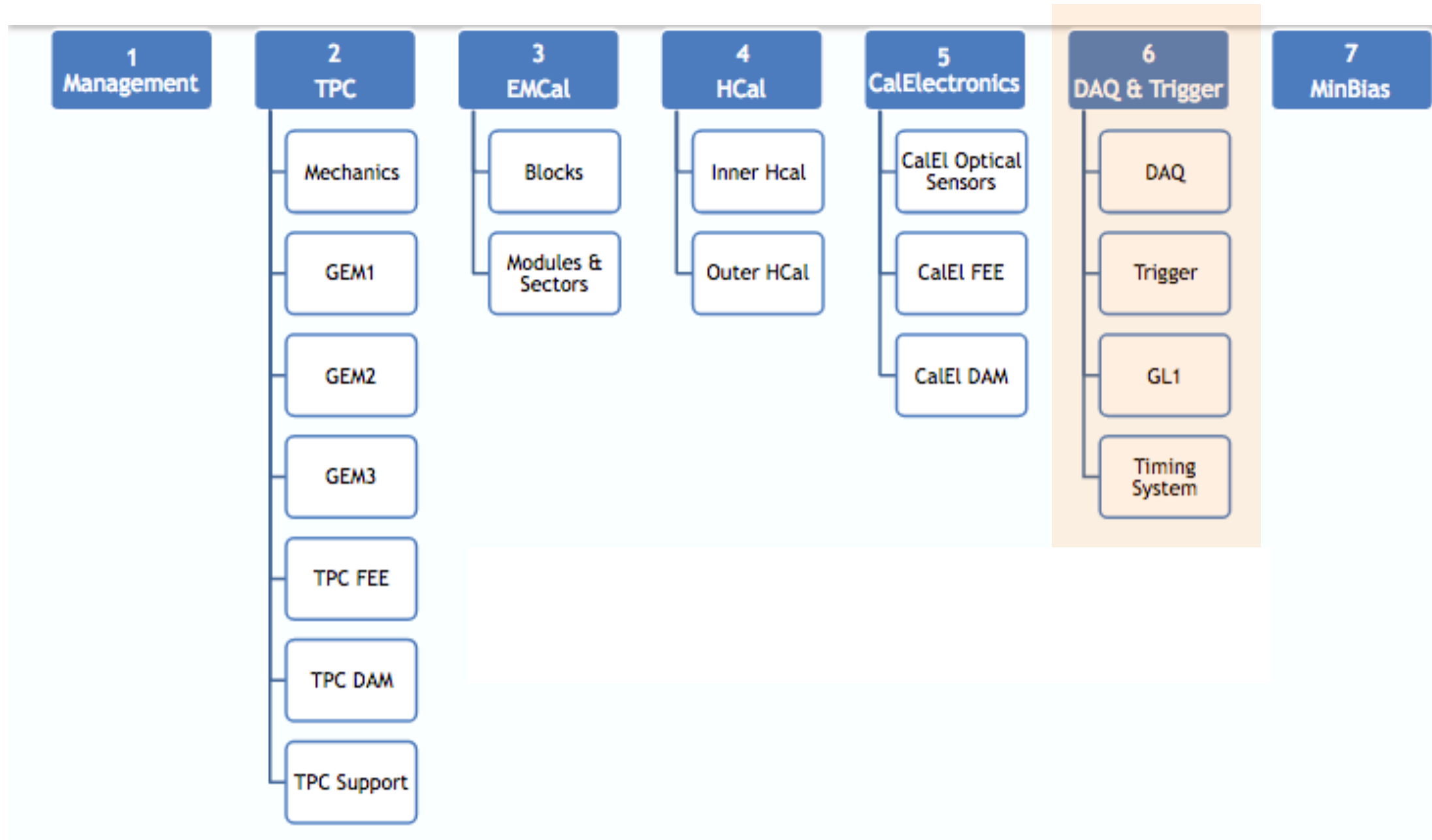
- 1.8 SC-Magnet
- 1.9 Infrastructure
- 1.10 Installation-Integration

WBS Parallel Activities

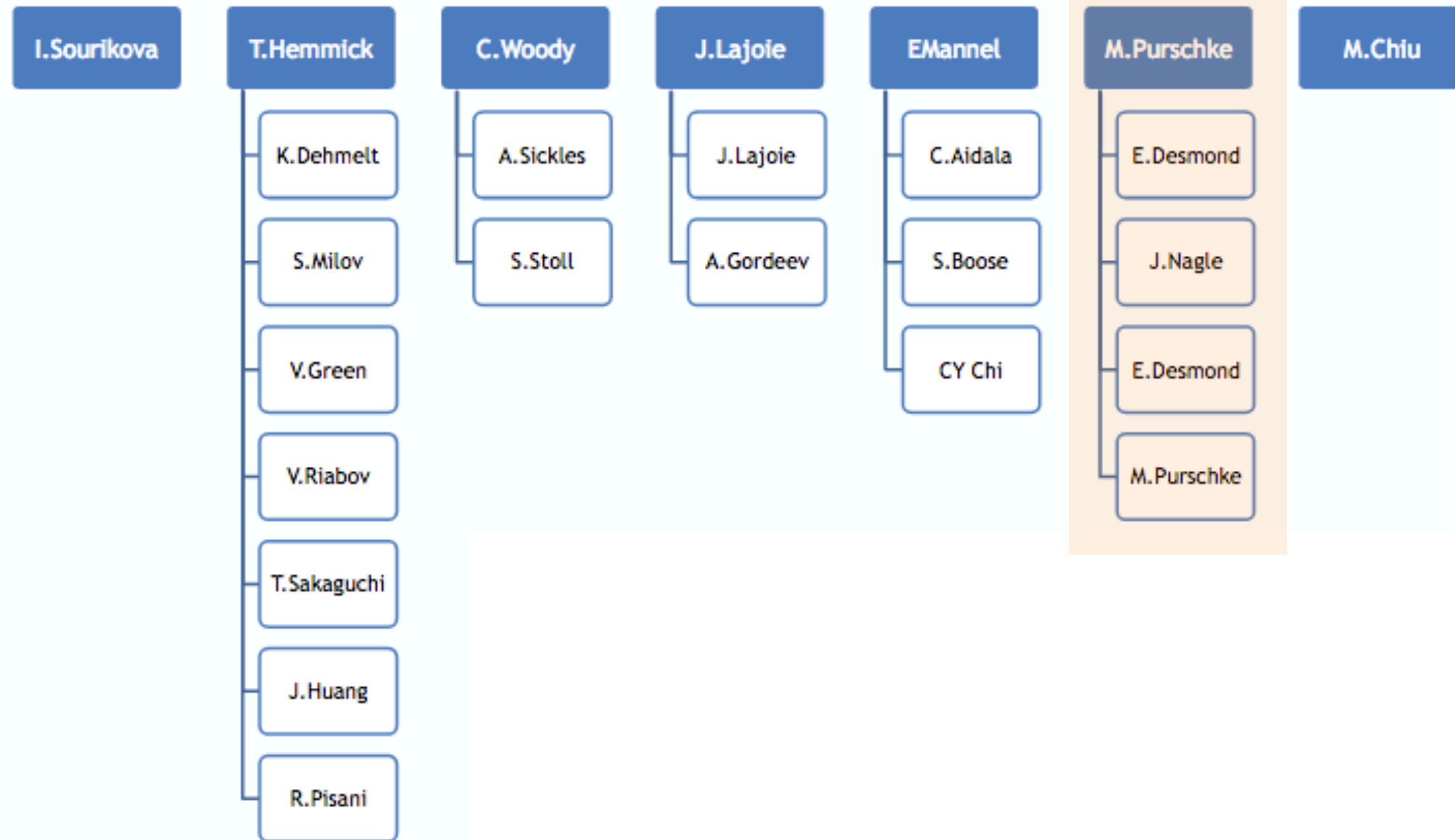
- 1.11 Intermediate Silicon Strip Tracker
- 1.12 Monolithic Active Pixel Sensor

L2 Manager: Martin L Purschke, BNL

WBS 1.6 – DAQ-Trigger



WBS 1.6 – DAQ-Trigger



What 1.6 contains

- The actual Data Acquisition 1.6.1
- The Trigger System 1.6.2
- The Global Level 1 1.6.3
- The Timing System 1.6.4

You will find all information in the assorted work package documents

sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)			
L2 Project Name DAQ/Trigger	L2 WBS Number 1.6	L3 Project Name (Control Account) Global Level 1 (L3 WBS Number
Work Package Name	WBS Number	Basis	
DAQ/Trigger: Global Level 1 Design	1.6.3.1	Global I	
DAQ/Trigger: Global Level 1 Prototype	1.6.3.2	Global I	
DAQ/Trigger: Global Level 1 Production	1.6.3.3	Global I	

sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)			
L2 Project Name DAQ/Trigger	L2 WBS Number 1.6	L3 Project Name (Control Account) DAQ	L3 WBS Number 1.6.2
Work Package Name	WBS Number	Basis of Estimate Link	
Trigger: Design	1.6.2.1	Trigger Design Summary	
Trigger: Prototype v1	1.6.2.2	Trigger Prototype v1 Summary	
Trigger: Preproduction Prototype	1.6.2.3	Trigger Preproduction Summary	
Trigger: Production	1.6.2.4	Trigger: Production	

What 1.6 contains

- The actual Data Acquisition 1.6.1
- The Trigger System 1.6.2
- The Global Level 1 1.6.3
- The Timing System 1.6.4

You will find all information in the assorted work package documents

sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)											
L2 Project Name DAQ/Trigger			L2 WBS Number 1.6			L3 Project Name (Control Account) Global Level 1 (Production)			L3 WBS Number 1.6.2		
sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)											
number											
L3 Project Name (Control Account) DAQ			L3 WBS Number 1.6.2								
WBS Number			Basis of Estimate Link								
1.6.2.1			Trigger Design Summary								
1.6.2.2			Trigger Prototype v1 Summary								
1.6.2.3			Trigger Preproduction Summary								
1.6.2.4			Trigger: Production								

Work Package I											
DAQ/Trigger: Global											
DAQ/Trigger: Global											
DAQ/Trigger: Global											
1.6.4.3	Timing System production										
1.6.4.3.1	Procure FPGA boards	FPGA Board	11500	5	\$57,500	11500	5	\$57,500	25%		\$14,375
1.6.4.3.2	Procure PCs amd misc. hardware	Server	1805	3		1805	3		20%		\$0
		Trunk fiber	5600	4		5600	4		20%		\$0
		MTP <-> MPT fiber couplers	225	4	\$900	225	4	\$900	48 -> 4x12	20%	
		Fiber patch panel	\$450	6	\$2,700	\$450	6	\$2,700	48 ports	20%	\$180
1.6.4.3.3	Final firmware updates										\$540
1.6.4.3.4	install timing system										\$0
1.6.4.3.5	commission timing system										\$0
1.6.4.3.6	Timing system ready to operate										\$0

What 1.6 contains

- The actual Data Acquisition System
- The Trigger System
- The Global Level 1
- The Timing System

You will find all information

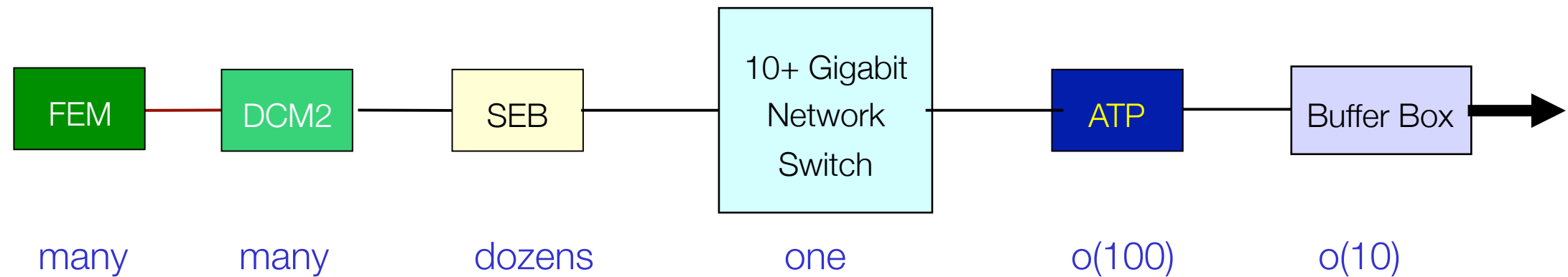
sPHENIX DAQ & TRIGGER	The Data Acquisition and Trigger System for the sPHENIX Experiment at RHIC.
DAQ	This work package covers the development cycles of the data acquisition system, from design to final commissioning.
DAQ Design	This work package covers the initial design of the data acquisition system, functions, and high-level components and boards.
DAQ Prototype	This work package delivers the first prototype of the DAQ system that demonstrates the proper functioning of the system. We expect this prototype to be usable or test beams and other related R&D efforts.
DAQ Production	This work package covers the final production and installation of the DAQ system.
Trigger	This work package covers the development cycles of the local level 1 trigger system, from design to final commissioning. This trigger forms higher-level trigger signals from individual detectors, such as the EmCAL, and passes them on to the Global Level 1 System. Due to the complexity of this system, we foresee 2 prototype stages here.
Trigger Design	This work package covers the design of the local level 1 trigger system, selection of hardware platforms to use, and a tentative selection of boards to use.
Trigger Prototype v1	This work package covers the first prototype of the local level 1 trigger system. This is considered a proof-of-principle that the design from 1.6.2.1 is viable, and will be used to determine required changes, if any.
Trigger LL1 Preproduction Prototype	This work package covers the preproduction version the local level 1 trigger system, which implements the changes derived from 1.6.2.2. This will be the final check that the system performs as designed.
Trigger LL1 Production	This work package covers the production, installation, and commissioning of the local level 1 trigger system.
Global Level 1 (GL1)	This work package covers the development cycles of the Global Level 1 (GL1) system, from design to final commissioning. The GL1 manages the triggering and busy states of the detector, and receives, in addition to the minimum bias information, the outputs of the local level 1 triggers.
GL1 Design	This work package covers the design of the Global Level 1 system. We will select the hardware components, and design the software and firmware components.
GL1 Prototype	This work package covers the prototype of the GL1 system. This will demonstrate the viability and proper functioning of the design, and show any problems in

sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)														
L2 Project Name DAQ/Trigger			L2 WBS Number 1.6			L3 Project Name (Control Account) Global Level 1 (L3 WBS Number					
sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)														
Work Package 1			Description			unit price \$	quantity	Sum	unit price \$	quantity	Sum	part nr / what	% Contingency	Contingency quote / info
DAQ/Trigger: Global														
DAQ/Trigger: Global							Primary			Alternate				
DAQ/Trigger: Global														
1.6.4.3			Timing System production											\$0
1.6.4.3.1			Procure FPGA boards			FPGA Board	11500	5	\$57,500	11500	5	\$57,500	25%	\$14,375
1.6.4.3.2			Procure PCs and misc. hardware			Server	1805	3		1805	3		20%	\$0
						Trunk fiber	5600	4		5600	4		20%	\$0
						MTP <->	225	4	\$900	225	4	\$900 48 -> 4x12	20%	\$0
						MPT fiber couplers								\$180
						Fiber patch panel	\$450	6	\$2,700	\$450	6	\$2,700 48 ports	20%	\$540
1.6.4.3.3			Final firmware updates											\$0
1.6.4.3.4			install timing system											\$0
1.6.4.3.5			commission timing system											\$0
1.6.4.3.6			Timing system ready to operate											\$0

sPHENIX Detector Relativistic Heavy Ion Collider BASIS of ESTIMATE (BoE)											
L3 Project Name (Control Account) DAQ			L3 WBS Number 1.6.2								
WBS Number			Basis of Estimate Link								
1.6.2.1			Trigger Design Summary								
1.6.2.2			Trigger Prototype v1 Summary								
1.6.2.3			Trigger Preproduction Summary								
1.6.2.4			Trigger: Production								

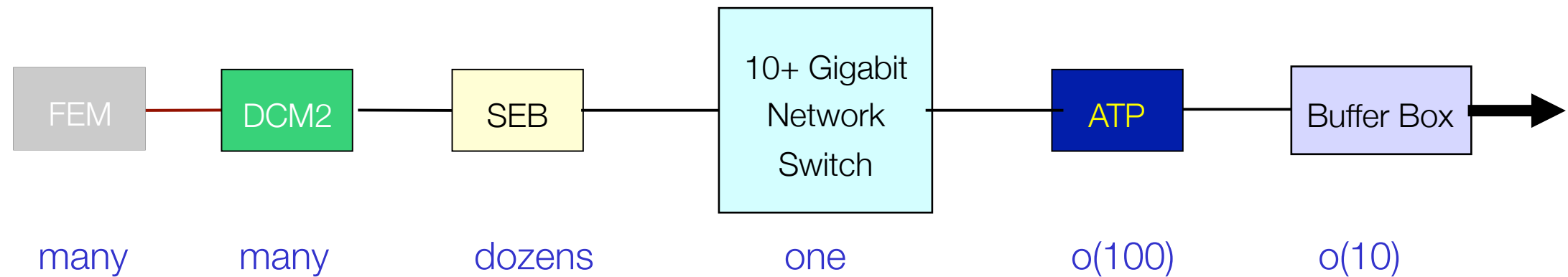
Package Walkthrough

- Front-end module
- Data Collection Module
- Sub-Event Buffer
- Network Switch
- Assembly and Trigger Module
- Buffer box



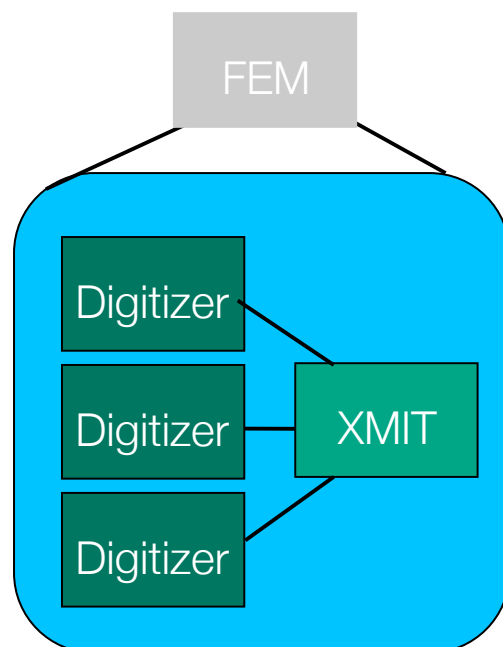
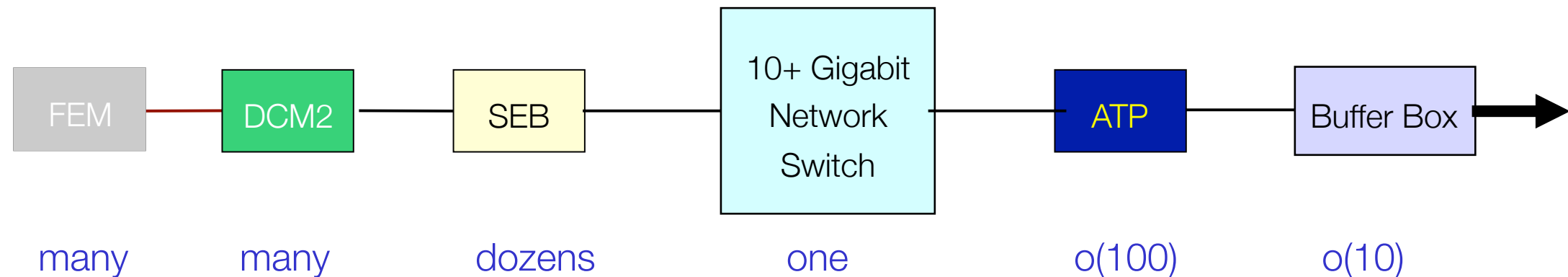
Package Walkthrough

- Front-end module
- Data Collection Module
- Sub-Event Buffer
- Network Switch
- Assembly and Trigger Module
- Buffer box



Package Walkthrough

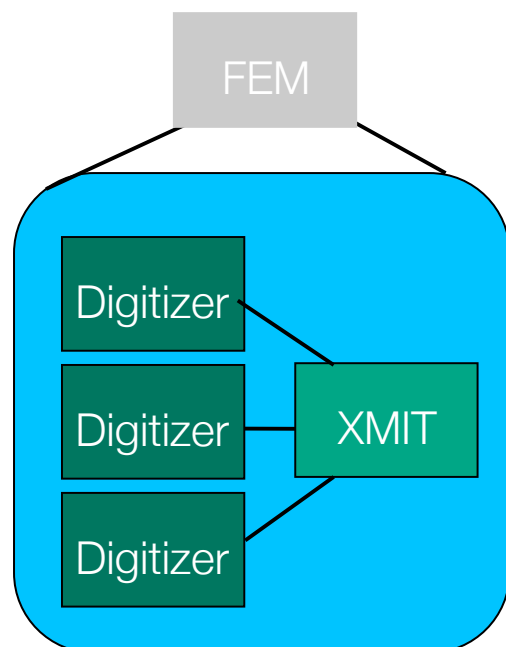
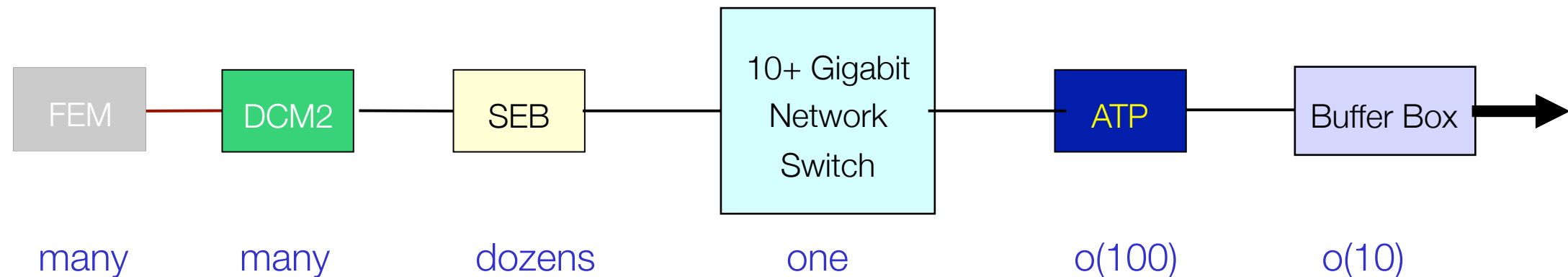
- Front-end module
- Data Collection Module
- Sub-Event Buffer
- Network Switch
- Assembly and Trigger Module
- Buffer box



A Calorimeter FEM from my perspective...
The FEM itself is not in my purview
But some connections to it are...

Package Walkthrough

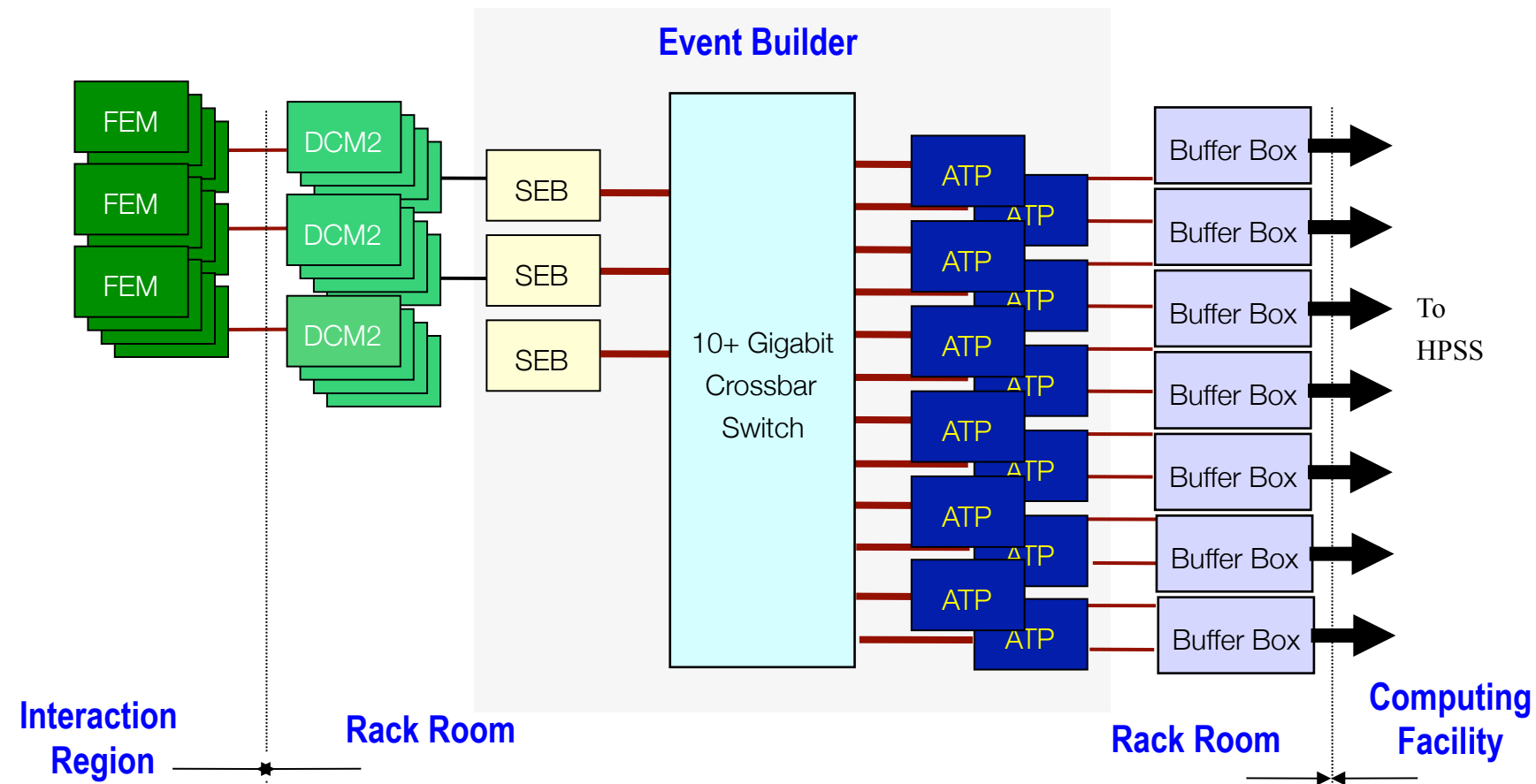
- Front-end module
- Data Collection Module
- Sub-Event Buffer
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- Buffer box



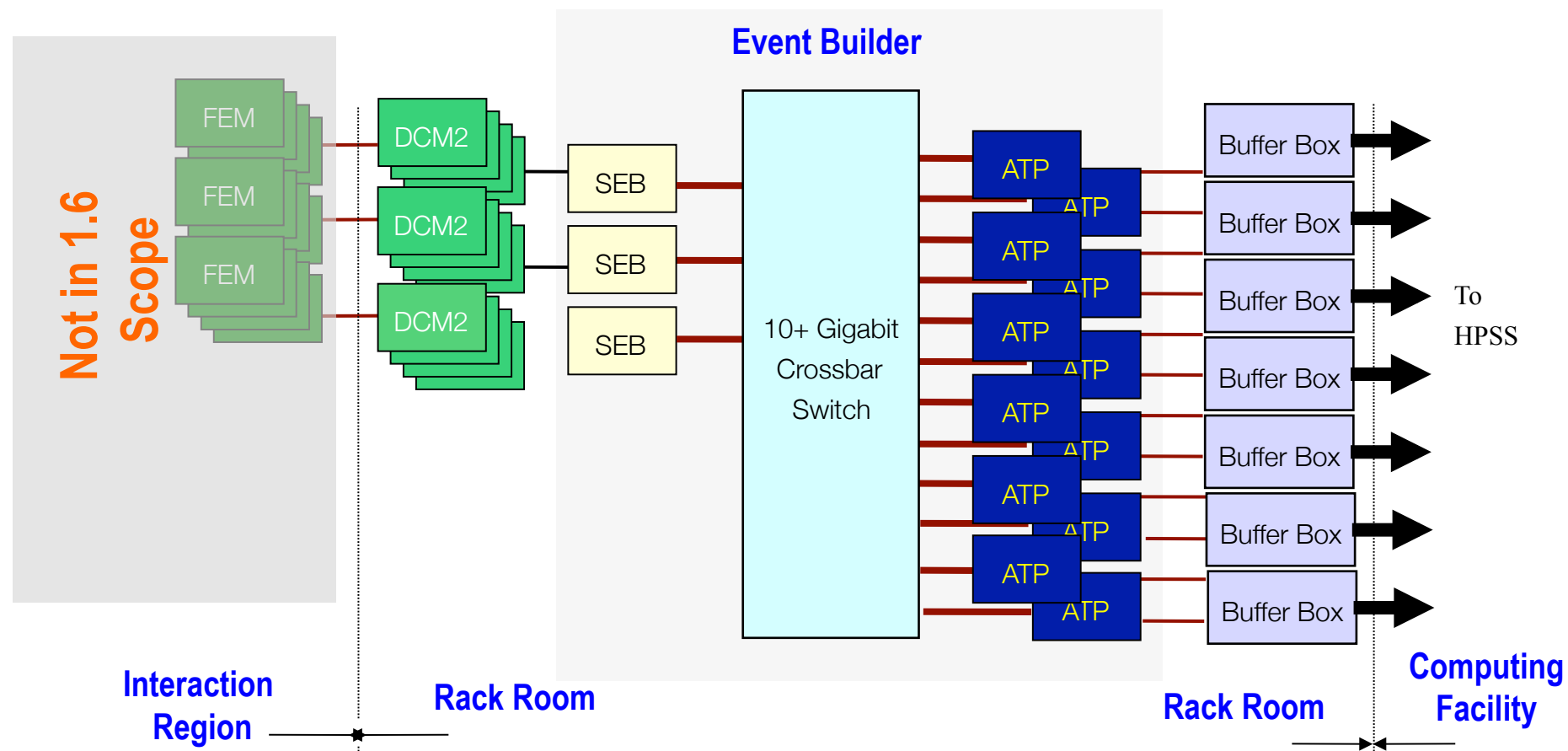
A Calorimeter FEM from my perspective.. .
The FEM itself is not in my purview
But some connections to it are.. .

I will stay with this iconography to walk you through the different documents

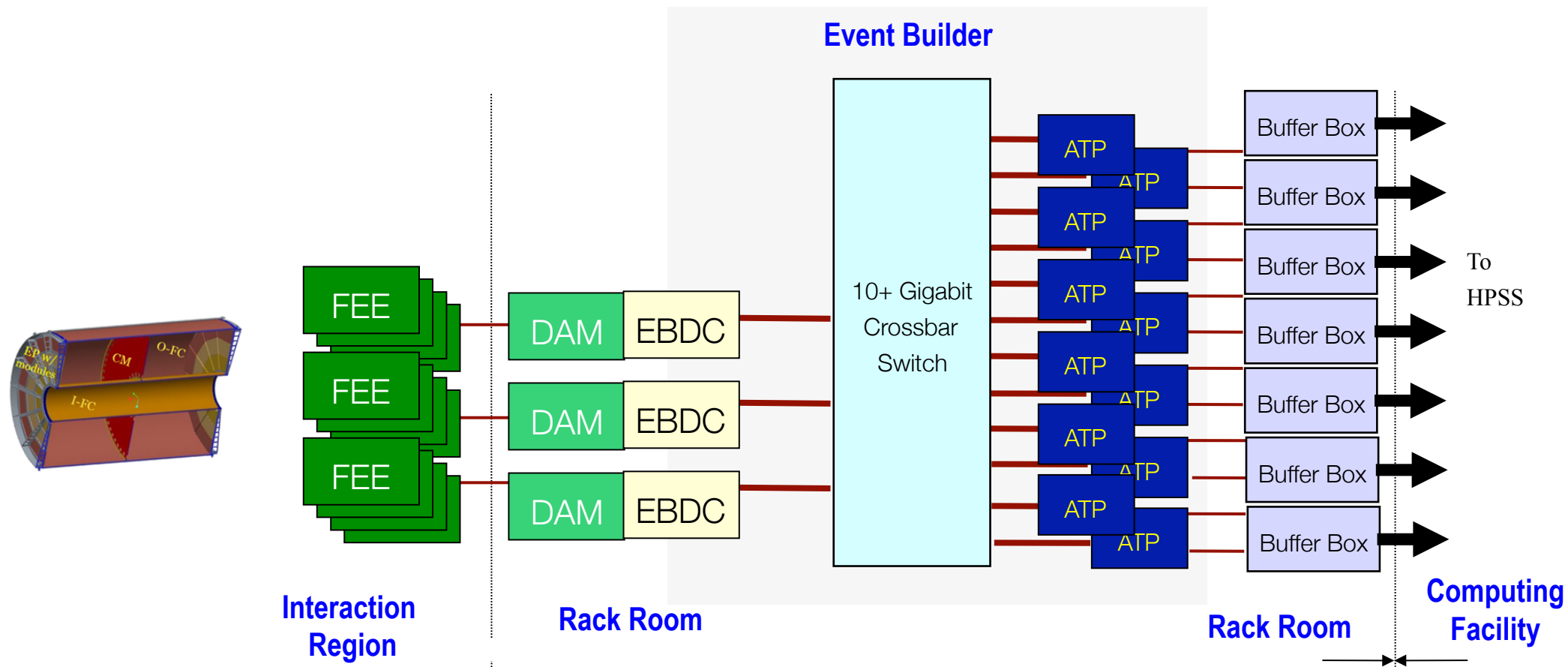
1.6.1 Data acquisition (calorimeters, VTX)



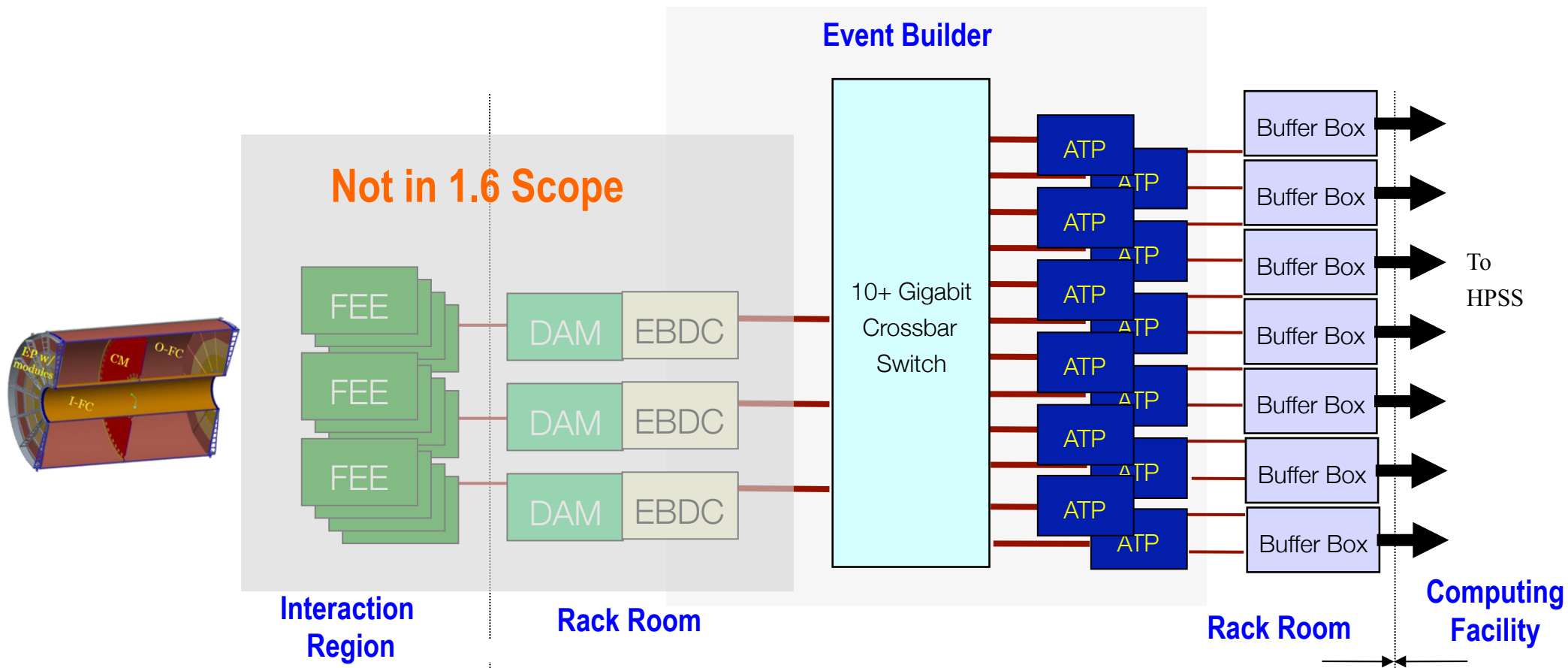
1.6.1 Data acquisition (calorimeters, VTX)



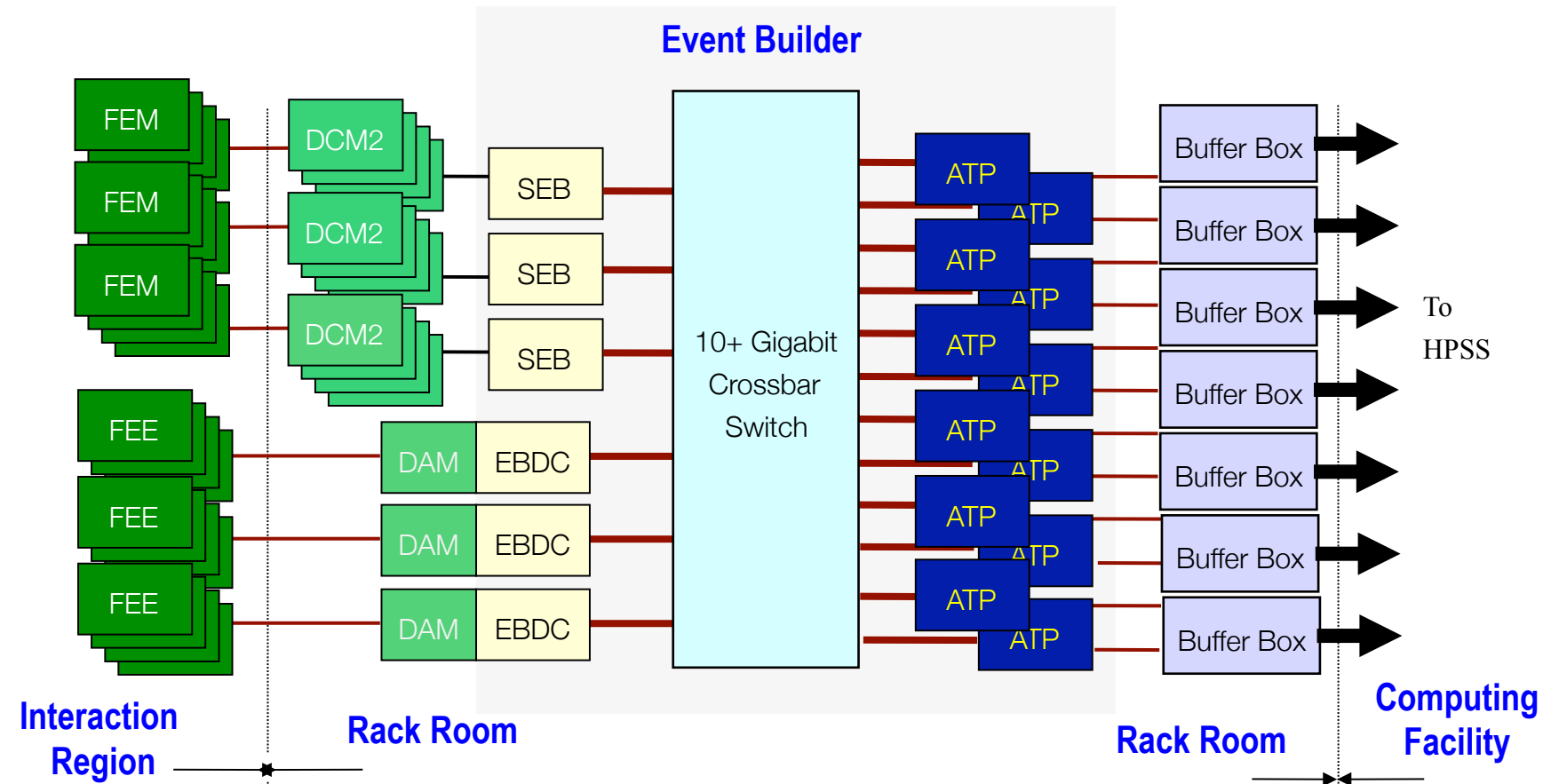
1.6.1 Data acquisition (TPC)



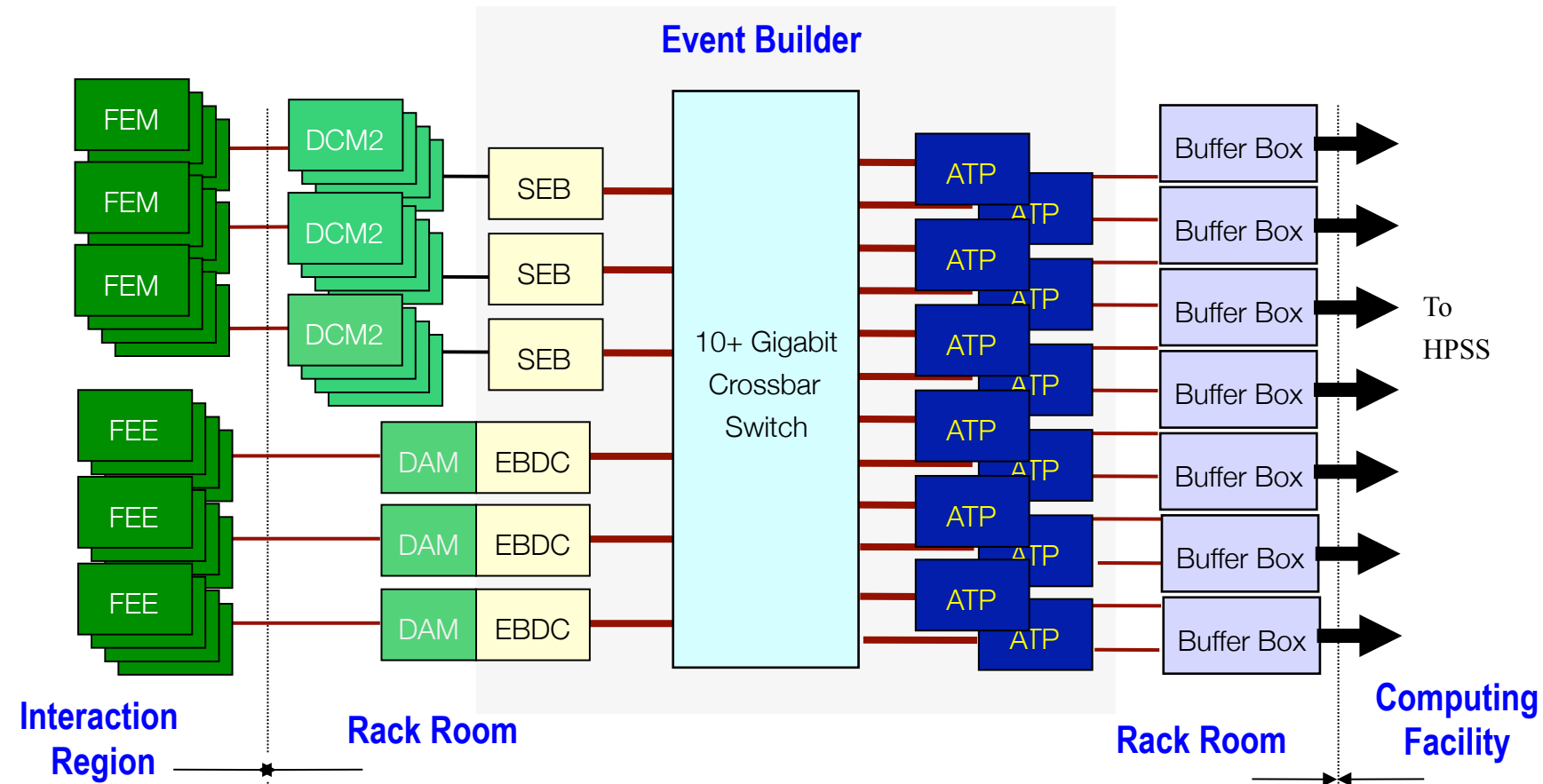
1.6.1 Data acquisition (TPC)



1.6.1 Data acquisition (All together)

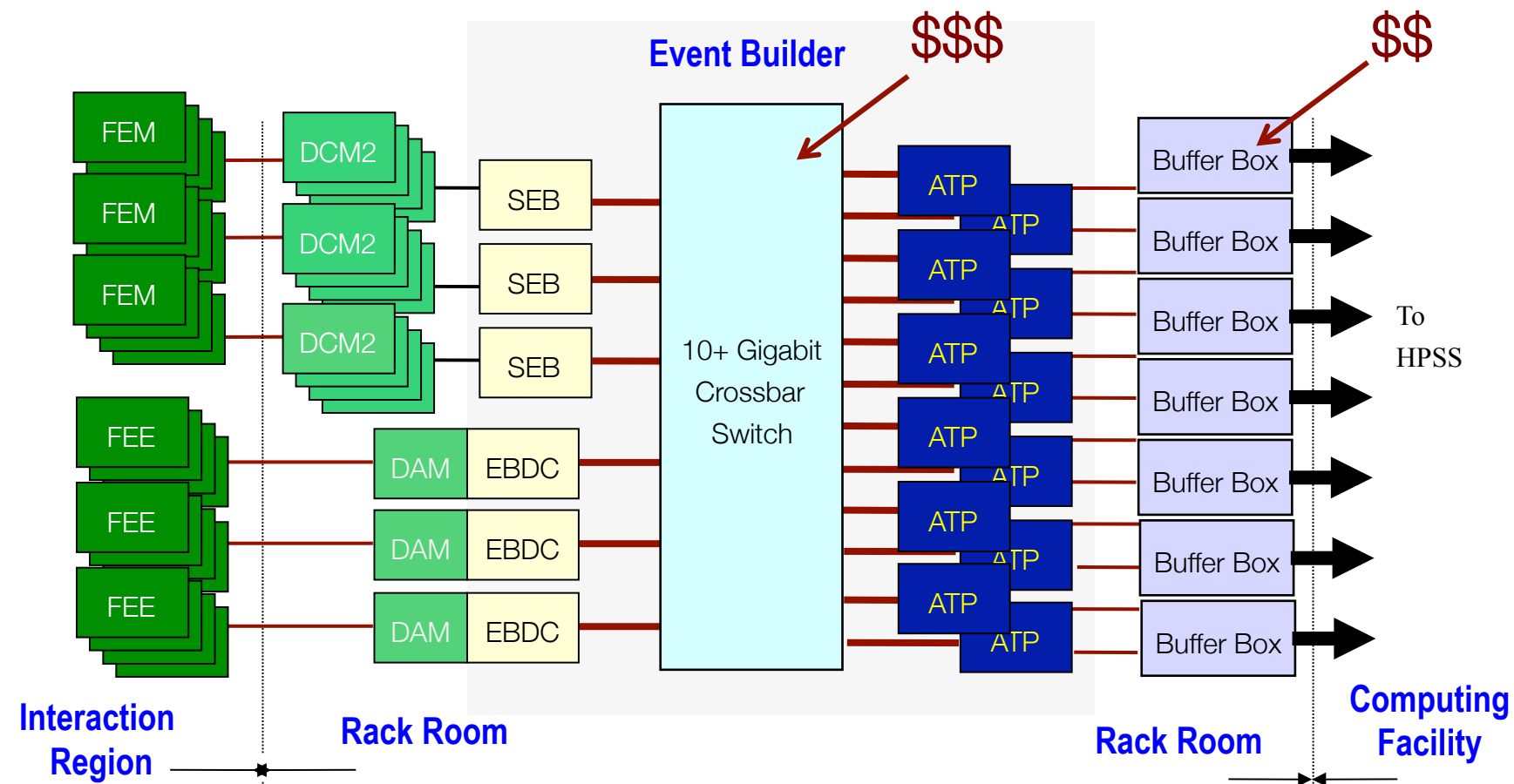


1.6.1 Data acquisition (All together)



- 1.6.1.1 Design
- 1.6.1.2 Prototype (virtually no procurements, re-using PHENIX hardware as much as possible)
- 1.6.1.3 Production/Commissioning (most procurements in 2019 / 20)

1.6.1 Data acquisition (All together)



- 1.6.1.1 Design
- 1.6.1.2 Prototype (virtually no procurements, re-using PHENIX hardware as much as possible)
- 1.6.1.3 Production/Commissioning (most procurements in 2019 / 20)

Local Level 1's - 1.6.2

What do they do?

- Derive information from a local detector/subsystem whether or not a given collision is “valuable” by some metrics (vertex position, high pT signal, Jet candidate, etc)
- Passes this information up to the Global Level 1 for the final decision
- Helps us to selectively take the interesting events
- Contributors:
 - Beam-Beam/Min Bias
 - EmCal

Local Level 1 - 1.6.2

High level of complexity and variety between detectors

Algorithm development, implementation, and hardware components

Budget for two prototype stages -

- 1.6.2.1 Design
- 1.6.2.2 Prototype v1
- 1.6.2.3 Preproduction Prototype
- 1.6.2.4 Production

Global Level 1 - 1.6.3

What does it do?

- Decides for each RHIC beam crossing if the data should be taken
- Receives and digests the Local Level 1 information
- Keeps track of the DAQ busy and manages multi-event buffering (how deep we have stacked events)
- Communicates with the per-detector front-ends with trigger and some housekeeping information

- 1.6.3.1 Design
- 1.6.3.2 Prototype
- 1.6.3.3 Production

Timing System - 1.6.4

What does it do?

- It distributes the RHIC clock to the front-end modules
- It sends the accepted trigger information to the FEMs
- It communicates house-keeping information to the FEMs

- 1.6.4.1 Design
- 1.6.4.2 Prototype
- 1.6.4.3 Production

Risk Registry

M. Purschke	1.6 DAQ/Trigger	DAQ Prototype	Tests with the various prototype stages reveal problems	DAQ prototype throughput and performance is below specifications	All	Moderate: 25%	Cost, increase number of boards/PCs	Low	Acquire more expensive PCs / re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Network switch	One of the currently identified vendors go out of business	Network switch more expensive than projected	Production	Low 20%	Cost due to lack of alternatives, Schedule (1Month)	Low	alternate vendors, different brands / getting acquainted with potentially new software interface
M. Purschke	1.6 DAQ/Trigger	Global Lvl1	Loss of engineering expertise due to employees leaving	adaptation of PHENIX GL1 runs into obstacles	Production	Low 20%	Schedule (2 months)	Low	select different card, identify a different engineer
M. Purschke	1.6 DAQ/Trigger	Timing System	insufficient number of now-obsolete parts	Conversion/adaptation from GLINK problematic, or envisioned replacement board cannot be used	All	Low 10%	Schedule 3 months	Low	select different card, re-engineer fiber interface
M. Purschke	1.6 DAQ/Trigger	Local LVL1	Simulations reveal the failure of an envisioned algorithm	Performance of LLVL1 algorithms inadequate. Trigger latency too high.	Production	Moderate 30%	Schedule 3 months	Moderate	Prioritize Physics goals, procure more hardware
M. Purschke	1.6 DAQ/Trigger	Storage	The TPC or other subsystem cannot meet the envisioned data reduction specifications	Data volume, especially from the TPC, too high	Production	Moderate 30%	cost (\$100K)	Moderate	Invest in more local storage, change compression algorithms

Local Lvl1 “Simulations reveal the failure of an envisioned algorithm”

Storage “The TPC or other subsystem cannot meet the envisioned data reduction specifications”

WBS Dictionary Example

1.06.01.03: DAQ Production

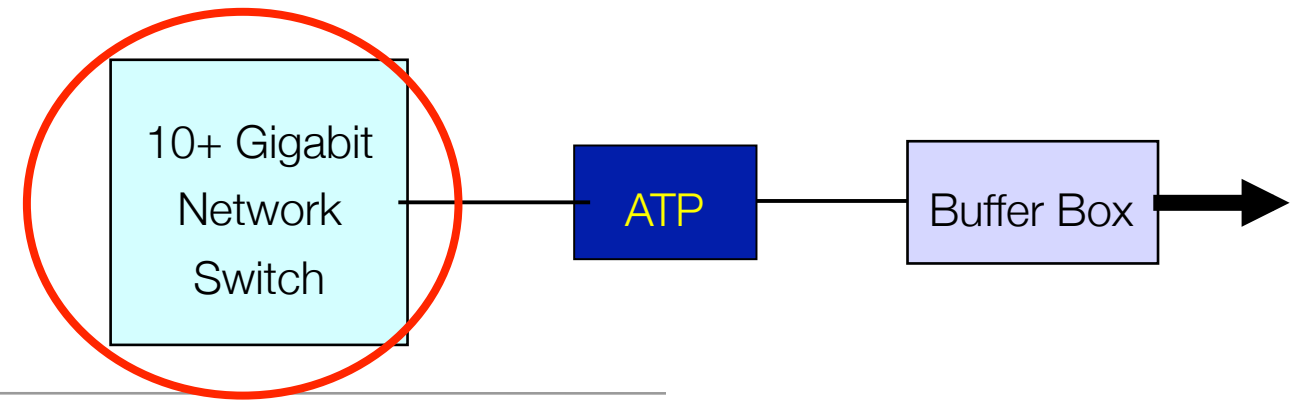
Deliverable: A working DAQ system as specified in the design phase and amended after reviews

Task	Task Description	Duration (d)	Scientist		Engineer		Designer		Technician		Trades		Student		Materials and Supplies		Risk Code		Notes
			FTE	days	FTE	days	FTE	days	FTE	days	FTEs	days	FTEs	days		Labor	Material		
			FTE	#days	FTE	#days	FTE	#days	FTE	#days	FTE	#days	FTE	#days					
Design and layout the various types of front-end boards	Get the board designs ready to be fabricated	40	0.2	40	0.1	40											7		Ony minor modifications from the existing boards are expected.
Board production	Fab the right number of boards	80			0.1	10										250000	7	3	We expect 25 boards for about \$10000 each
Firmware development	Develop and upgrade the f1rmware for the boards	600	0.2	60	0.1	60								0.5	60		7		Especially the JSEB boards will need firmware modifications to mplement the zero-suppression for the new calorimeters
Crate procurement	get the required number of crates.	1000	0.1	100	0.1	100										72000		3	Assume 12 crates for \$5000
Crate installation	get the crates inatalled in rack, connect power, cooling	400	0.1	40	0.1	40				0.8	40	0.1	40				7		
Procure SEBs	After the required number of SEBs has been established, procure them																		
Procure ATPs	Select and procure the right number of machines	100	0.1	100	0.1	100										100,000		7	3
Procure jSEB Slow control computers	These machines hold the jSEB cards for the slow controls	100	0.1	100	0.1	100										200,000		7	3
		100	0.1	100	0.1	100										200,000		7	3

Milestones

1.6.1.3.4	Crate Procurement and Installation	4/3/19	10/21/19
1.6.1.3.6	Procure event builder machines	4/3/19	8/23/19
1.6.1.3.12	Procuring the main Network switch	5/30/19	11/19/19
1.6.1.3.16	DAQ Software commissioning	3/2/20	5/92/20
1.6.2.4.4	Procure Components for Trigger	4/29/19	6/10/19
1.6.2.4.6	Assemble and commission trigger system	6/11/19	6/24/19
1.6.3.3.1	Procure final GL1 hardware	10/29/18	12/12/18
1.6.3.3.5	commission GL1 system	3/28/19	8/5/19
1.6.4.3.2	Procure PCs for Timing System	8/31/18	11/9/18
1.6.4.3.5	commission Timing System	3/14/19	7/8/19

Individual \$\$\$ items



2000 14th Street North
Suite 770

Account Manager: Daniel L. Haney
Phone: 5712866245
Email: dan@sunmanagement.net
Fax: 7037783797

Quote Number: DCKHQ1019-01
Date: 05-17-16
Valid Until: 06/16/16

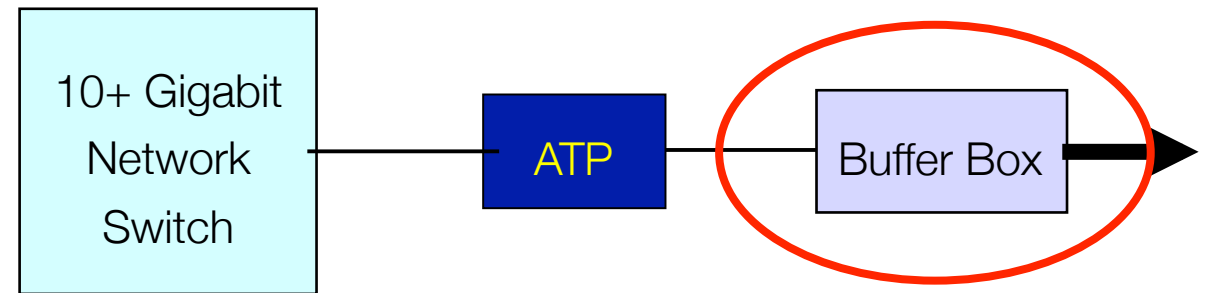
SubTotal	\$109,347.20
Tax	TBD
Total	\$109,347.20
Total with Credit Card	\$111,534.14

Sold To	Ship To	Corporate Information
Brookhaven National Laboratory Frank Burstein Brookhaven National Laboratory Receiving: Bldg 98 Rochester St Upton, NY 11973 Phone (631) 344-2313 Fax Email fburs01@bnl.gov	Brookhaven National Laboratory Frank Burstein Brookhaven National Laboratory Receiving: Bldg 98 Rochester St Upton, NY 11973 Phone (631) 344-2313 Fax Email fburs01@bnl.gov	TIN: 364546036 DUNS: 36-116-5561 Small Business: SBA P064494 Notes *Confidential ARISTA Pricing for DOE- BNL Only*

P.O. Number	Ship Via	Terms
	UPS	

Line	Qty	Item	Description	Mfg List Price	Discount	Price Ea.	Ext. Price
1	2	DCS-7280SE-72-F	Arista 7280E, 48x10GbE (SFP+) & 2x100GbE MXP switch, front-to-rear air, 2x AC and 2xC13-C14 cords	\$24,995.00	36%	\$15,996.80	\$31,993.60
2	24	SVC-7280SE-72-1M-NB	1 Month A-Care Software & NBD Hardware Replacement/Same Day Ship for 7280SE-72	\$335.00	15%	\$284.75	\$6,834.00
3	4	DCS-7010T-48-F	Arista 7010T, 48x RJ45 (100/1000), 4 x SFP+ (1/10GbE) switch, front to rear air, 2x AC, 2xC13-C14 cords	\$7,995.00	36%	\$5,116.80	\$20,467.20
4	4	LIC-7048-E	Enhanced License for Arista 48-port Gigabit Ethernet Switches (OSPF, BGP, PIM)	\$3,594.00	100%	\$0.00	\$0.00
5	48	SVC-7010T-1M-NB	1 Month A-Care Software & NBD Hardware Replacement/Same Day Ship for 7010T-48	\$34.00	15%	\$28.90	\$1,387.20
6	2	DCS-7010T-48-R	Arista 7010T, 48x RJ45 (100/1000), 4 x SFP+ (1/10GbE) switch, rear to front air, 2x AC,	\$7,995.00	36%	\$5,116.80	\$10,233.60

Individual \$\$\$ items (2)



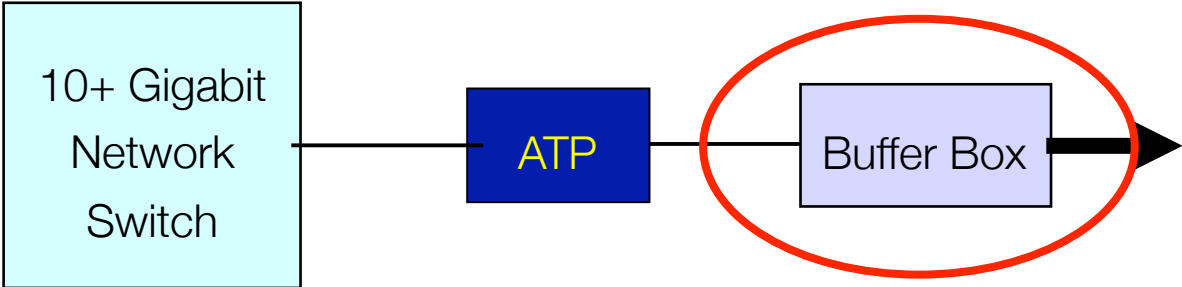
RS-Ability4U-84Bay-EBOD-672TB-8401

QTY	PART #	DESCRIPTION	EXTENDED
16.00	Ability 4U 84 Bay Full 12Gb	4U x 84 3.5" Drive Dual 12G JBOD Includes: • (2) 12Gb SAS I/O Module • (1) 12Gb Baseboard • (2) 12V Output Only Power and Cooling Modules • (1) Standard Adjustable Rail Kit • (1) Cable Management Assembly	\$517,008.00
1,344.00	3.5" 8TB SAS 12Gb/s 7.2K RPM 256M 512E	Seagate 3.5", 8TB, SAS 12Gb/s, 7.2K RPM, 256M, 512E, Performance (MAKARA+),	Included
32.00	3M SAS 12G Cable	3M SAS 12G Cables	Included
16.00	**LSI 9300-8e 12Gb/s SAS Dual-port HBA	12Gb/s SAS, dual port x8 lane PCI Express® 3.0	Included
1.00	*RS-T2-36	RAIDserv support services - NBD cross ship with parts replacement, including firmware updates and 24 hour phone support, 36 months.	Included
RS-Ability4U-84Bay-EBOD-672TB-8401 TOTAL:			\$517,008.00

TOTAL: \$517,008.00

$$\$517,000 / 16 * 6 = \$195,000$$

Individual \$\$\$ items (2)



RS-Ability4U-84

QTY	PART #
16.00	Ability 4
1,344.00	8.5" 8TB 256M 5
32.00	3M SAS
16.00	**LSI 93 HBA
1.00	*RS-T2

Machine in the RACF
(being set up)

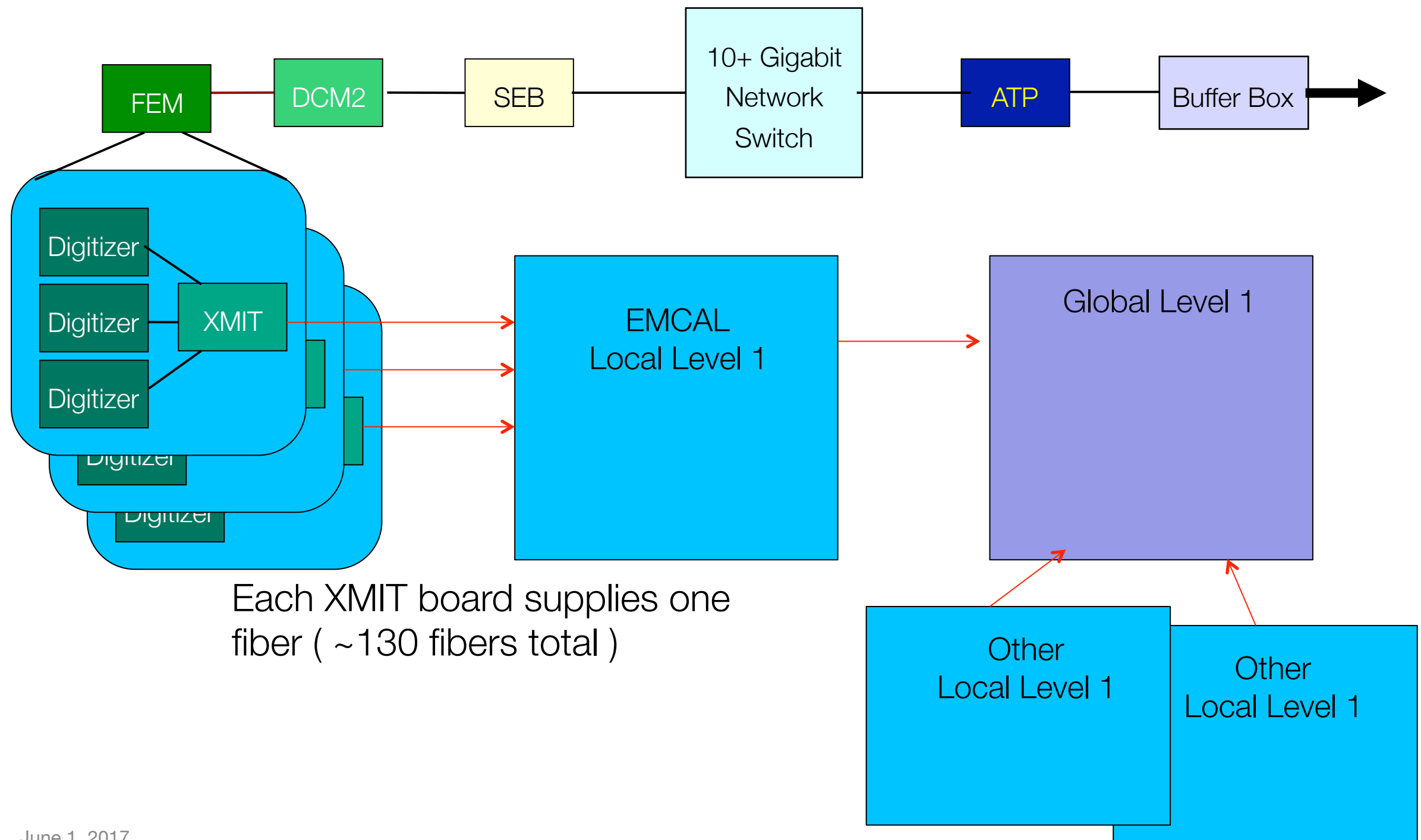
	EXTENDED
	\$517,008.00
	Included
	Included
	Included
	Included
TOTAL:	\$517,008.00

TOTAL: \$517,008.00

$\$517,000 / 16 * 6 = \$195,000$

Backup Slides

Example: Emcal Local Level 1



Example: Emcal

